

AMENDMENTS TO THE CLAIMS

Please amend claim 1 as directed below. Claims 2-41 and 140-143 have not been revised but are reprinted below for the Examiner's convenience. The claims have thus been revised in the manner required by 37 C.F.R. §1.121.

1. (Currently Amended) A system for [~~creating~~] administering into [~~bubbles on demand for use within a medium administrable to~~] a patient a medium in which bubbles therein are created according to [~~for purposes~~] the demands of a medical procedure, said system comprising:

- (a) a reservoir for storing a liquid;
- (b) a pressurizing device for conveying the liquid, and the medium formed therewith, through said system;
- (c) a bubble generator for creating the bubbles of gas within the liquid to form the medium, said bubble generator having an inlet for receiving the liquid and an outlet for communication of the medium to the patient; and
- (d) a controller for controlling operation of said system real-time so that the bubbles created by said bubble generator are generated according to the demands of the medical procedure and [~~are administrable~~] then administered within the medium to the patient.

2. (Original) The system of claim 1 wherein said pressurizing device includes at least one of a gear pump, a peristaltic pump, a syringe pump and a centrifugal pump.

3. (Original) The system of claim 1 wherein said controller controls at least one operating parameter of said pressurizing device and said bubble generator.

4. (Original) The system of claim 1 wherein said controller controls at least one operating parameter of said system based at least in part on feedback from an imaging unit used during the medical procedure.

5. (Original) The system of claim 1 wherein said controller includes a user interface for at least one of monitoring and changing at least one operating parameter of said system.

6. (Original) The system of claims 3, 4, or 5 wherein said operating parameters of said system include composition of the medium, composition of the bubbles in the medium, concentration of the bubbles in the medium, size of the bubbles in the medium, rate of flow of the medium, volume of the medium administered, timing of the administration of the medium, sequencing of the administration of the medium, pressure of the medium, and temperature of the medium.

7. (Original) The system of claim 1 further comprising a fluid verification device disposed between said bubble generator and the patient, said fluid verification device for at least one of monitoring and changing at least one operating parameter of said system.

8. (Original) The system of claim 7 wherein said fluid verification device is capable of at least one of (i) detecting an unacceptably large amount of the gas and preventing administration thereof to the patient and (ii) destroying any of the bubbles having a diameter at least one of greater than, less than, within, and outside a predetermined range of sizes.

9. (Original) The system of claim 7 wherein said controller at least one of communicates with and controls operation of said fluid verification device.

10. (Original) The system of claim 7 wherein said controller controls operation of said system based at least in part on information from said fluid verification device.

11. (Original) The system of claim 1 wherein said bubble generator creates the bubbles by entraining the gas from a source thereof into a flow of the liquid to form the medium.

12. (Original) The system of claim 11 further comprising a fluid verification device disposed between said bubble generator and the patient, said fluid verification device for preventing administration of the medium upon at least one of a rate of flow of the medium dropping below a specified level and detecting that the medium contains an unacceptably large amount of the gas.

13. (Original) The system of claim 1 wherein said bubble generator comprises:

(a) an enclosure within which to agitate the liquid in presence of the gas; and

(b) a means for disrupting an interface between the liquid and the gas, said disrupting means being responsive to a control signal from said controller by agitating said interface thereby creating the bubbles of the gas within the liquid.

14. (Original) The system of claim 1 wherein said bubble generator comprises:

(a) an enclosure within which to agitate the liquid in presence of the gas;

(b) a mechanism for agitating associated with said enclosure, said mechanism being responsive to a control signal from said controller by agitating an interface between the liquid and the gas thereby creating the bubbles of the gas within the liquid; and

(c) a filter disposed proximate said outlet for removing from the medium any of the bubbles having a diameter greater than a predetermined size.

15. (Original) The system of claim 1 wherein said bubble generator comprises:

(a) an enclosure within which to place the liquid in presence of the gas;

(b) two disks disposed in said enclosure, said disks separated by a gap of a preset thickness and capable of being spun;

(c) a mechanism for spinning said disks, said mechanism being responsive to a control signal from said controller by spinning said disks thereby compelling the liquid to flow into said gap resulting in creation of the bubbles of the gas within the liquid; and

(d) a filter disposed proximate said outlet of said enclosure for removing from the medium any of the bubbles having a diameter greater than a predetermined size.

16. (Original) The system of claim 1 wherein said bubble generator comprises:

(a) an enclosure within which to place the liquid in presence of the gas;

(b) a stirring element disposed in said enclosure;

(c) a mechanism for moving said stirring element, said mechanism being responsive to a control signal from said controller by moving said stirring element thereby causing the creation of the bubbles of the gas in the liquid; and

(d) a filter disposed proximate said outlet of said enclosure for removing from the medium any of the bubbles having a diameter greater than a predetermined size.

17. (Original) The system of claim 16 wherein said stirring element comprises multiple small wires.

18. (Original) The system of claim 1 wherein the liquid is supersaturated with the gas under pressure and has nucleation materials therein, with said bubble generator comprising a nozzle such that as the liquid passes therethrough the pressure of the liquid decreases causing the bubbles of the gas to form on the nucleation materials and come out of and entrain with the liquid, thereby forming the medium.

19. (Original) The system of claim 18 wherein the nucleation materials comprise at least one of particles and chemicals.

20. (Original) The system of claim 1 wherein the liquid is supersaturated with the gas under pressure as the liquid enters said bubble generator, with said bubble generator comprising a nozzle having a plurality of nucleation sites formed therein such that as the liquid passes through said nozzle and contacts at least one of said nucleation sites the pressure of the liquid decreases causing the gas to come out of solution, forming the bubbles that entrain with the liquid thereby forming the medium.

21. (Original) The system of claim 20 wherein said nucleation sites take the form of pits formed in an inner wall of said nozzle.

22. (Original) The system of claim 20 wherein said nozzle is cylindrical in shape.

23. (Original) The system of claim 20 wherein said nozzle comprises plates attached together to form a pipe, with at least one of said plates bearing said nucleation sites.

24. (Original) The system of claim 1 wherein said bubble generator comprises:

- (a) an enclosure within which to place the liquid in which the gas is dissolved; and
- (b) a device, controlled by said controller, to apply energy to the liquid to create localized regions of gas supersaturation thereby enabling creation of the bubbles of the gas within the liquid to form the medium.

25. (Original) The system of claim 24 wherein said localized regions of gas supersaturation comprise regions of reduced pressure created by at least one of mechanical motion, an oscillatory pressure component, and an oscillatory flow component.

26. (Original) The system of claim 1 wherein said bubble generator comprises:

- (a) an enclosure within which to place the liquid in which a gas is dissolved; and
- (b) a transmitter for transmitting ultrasonic energy into the liquid to cause cavitation therein thereby enabling creation of the bubbles of the gas within the liquid to form the medium.

27. (Original) The system of claim 1 wherein said bubble generator comprises:

(a) a liquid flow path for receiving the liquid from said pressurizing device; and

(b) a gas flow path in communication with a source of the gas for directing the gas received therefrom to said liquid flow path;

with said liquid and said gas flow paths constituting a gas-liquid interface assembly such that said liquid flow path channels the liquid received from said pressurizing device to an intersection with said gas flow path to entrain the gas emanating therefrom as the bubbles, thereby forming the medium for communication from said outlet.

28. (Original) The system of claim 27 wherein said controller operates said pressurizing device and said source of the gas to produce an oscillatory component to the flow within at least one of the gas flowing in said gas flow path and the liquid flowing in said liquid flow path.

29. (Original) The system of claim 27 wherein said bubble generator comprises an array of said gas-liquid interface assemblies.

30. (Original) The system of claim 27 wherein said bubble generator further comprises a fluid flow path for receiving a second liquid from said pressurizing device and for channeling the second liquid received therefrom into the liquid into which the gas has been entrained, thereby further forming the medium for communication from said outlet.

31. (Original) The system of claim 30 wherein said bubble generator comprises an array of said gas-liquid interfaces.

32. (Original) The system of claim 1 wherein said bubble generator comprises:

(a) a gas introduction plate having a plurality of gas inlets in communication with a source of the gas; and

(b) a liquid flow path for receiving the liquid from said pressurizing device and for channeling the liquid received therefrom over said gas introduction plate to entrain as the bubbles the gas emanating from said gas inlets, thereby forming the medium for communication from said outlet.

33. (Original) The system of claim 32 wherein said controller operates said pressurizing device and said source of the gas to produce an oscillatory component to the flow within at least one of the gas flowing in said gas inlets and the liquid flowing in said liquid flow path.

34. (Original) The system of claim 32 wherein said bubble generator further comprises a secondary plate disposed a predetermined distance apart from said gas introduction plate between which the liquid is channeled by said liquid flow path, said predetermined distance being selected to affect a size of the bubbles so entrained.

35. (Original) The system of claim 34 wherein said secondary plate has a plurality of gas inlets by which the gas is further so entrained by the liquid flowing in said liquid flow path.

36. (Original) The system of claim 1 wherein said bubble generator comprises:

(a) a tube having a plurality of gas inlets defined in a wall thereof and one end for receiving the liquid from said pressurizing device, with said gas inlets adapted for communication with a source of the gas;

with said tube for channeling the liquid received from said pressurizing device over said gas inlets to entrain the gas emanating therefrom as the bubbles, thereby forming the medium for communication from said outlet.

37. (Original) The system of claim 36 wherein said controller operates at least one of said pressurizing device and said source of the gas to produce an oscillatory component to the flow of at least one of the liquid and the gas.

38. (Original) The system of claim 1 wherein said bubble generator comprises:

(a) a chamber defining a plurality of gas inlets in communication with a source of the gas;
and

(b) a liquid flow path defined within said chamber;

with said liquid flow path for channeling the liquid received from said pressurizing device to an intersection with said gas inlets to entrain the gas emanating therefrom as the bubbles, thereby forming the medium for communication from said outlet.

39. (Original) The system of claim 38 wherein said controller operates at least one of said pressurizing device and said source of the gas to produce an oscillatory component to the flow of at least one of the liquid and the gas.

40. (Original) The system of claim 1 wherein said bubble generator comprises:

(a) a first member having outer and inner sides with a plurality of inlet holes extending therebetween, said outer side of said first member for channeling the first liquid over said inlet holes;

(b) a second member having inner and outer sides with a plurality of outlet holes extending therebetween, said outer side of said second member for channeling the liquid over said outlet holes, said inner sides of said first and said second members being separated by a gap and arranged so that each of said inlet holes aligns with one of said outlet holes, said gap for channeling the gas between said first and said second members; and

(c) a means for generating droplets of the liquid such that each of said droplets is directed through one of said inlet holes, said outlet hole corresponding thereto and the gas present therebetween and into the liquid on said outer side of said second member thereby forming a bubble therefrom within the liquid to form the medium therefrom.

41. (Original) The system of claim 1 wherein said bubble generator comprises:

(a) a plate having a first surface and a second surface with an inlet hole extending therebetween, said first surface and a wall of said inlet hole being in contact with the liquid; and

(b) a heater in communication with said wall of said inlet hole to form an interface assembly therefrom; such that, upon application of a pulse of energy to said heater, said heater heats the liquid in said inlet hole to form a bubble of gas therefrom, the bubble moving from said interface assembly into the liquid flowing along said second surface to form the medium therefrom.

42-139. (Previously Withdrawn)

140. (Original) A system for creating a plurality of differentiable populations of bubbles of gas for use within a medium administrable to a patient for purposes of a medical procedure, said system comprising:

(a) at least one reservoir for accommodating at least one of a liquid and the gas;

(b) at least one pressurizing device for conveying at least one of the liquid and the gas, and the medium formed therewith, through said system; and

(c) at least one bubble generator having at least one inlet for receiving the liquid and the gas and creating therefrom said plurality of differentiable populations of bubbles, said at least one bubble generator having at least one outlet for communication of the medium, and said plurality of differentiable populations of bubbles therein, to the patient.

141. (Original) The system of claim 140 further comprising a controller for controlling operation of said system so that said plurality of differentiable populations of bubbles created by said at least one bubble generator are generated according to the demands of the medical procedure and are administrable within the medium to the patient.

142. (Original) The system of claim 141 wherein said controller controls at least one operating parameter of said at least one bubble generator.

143. (Original) The system of claim 142 wherein said operating parameters include composition of the medium, composition of the bubbles in the medium, concentration of the bubbles in the medium, size of the bubbles in the medium, rate of flow of the medium, volume of the medium administered, timing of the administration of the medium, sequencing of the administration of the medium, pressure of the medium, and temperature of the medium.